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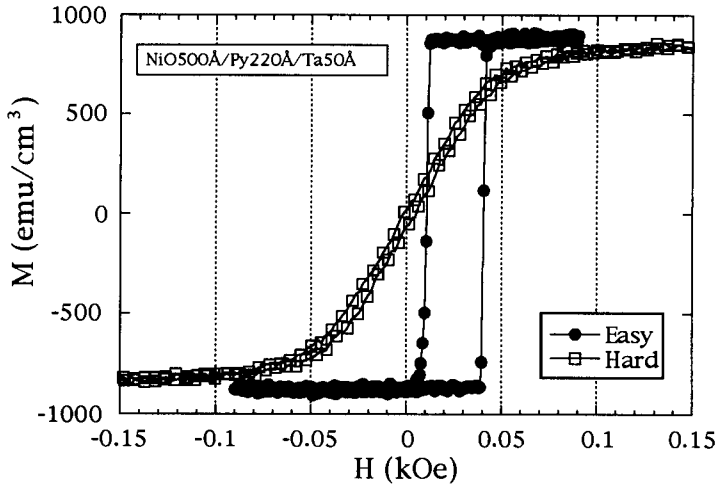
NiO EXCHANGE BIAS LAYERS GROWN BY DIRECT ION BEAM SPUTTERING OF A NICKEL OXIDE TARGET

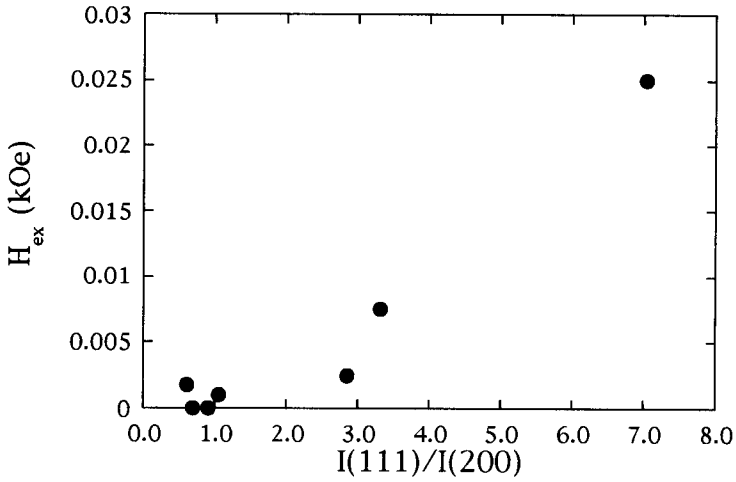
Richard P. Michel and A. Chaiken,
Mailstop L-268, Lawrence Livermore National Lab, Livermore CA 94550
Y.K. Kim,
Quantum Peripherals Colorado Inc., 2270 S. 88th St., Louisville, CO 80028

NiO exchange bias films have conventionally been grown by reactive magnetron sputtering of Ni targets in an oxygen atmosphere[1]. We have produced NiO exchange bias layers by directly ion beam sputtering a NiO target without introducing oxygen gas. The exchange bias fields H_{ex} of NiFe films deposited on the NiO films produced with IBS are comparable to those achieved using the reactive magnetron sputtering technique. We have studied the effects of a range of deposition parameters on H_{ex}. The direct-sputtering method allows us to fabricate high quality exchange-biased spin valve structures without exposing the NiO surface to atmosphere.



The deposition is performed with a Kauffman ion source in a chamber with a base pressure of $2x10^{-8}$ torr. The target to substrate distance is about 25 cm. The substrate carousel is electrically and thermally isolated so that films can be grown at different temperatures and voltage biases. Each substrate is mounted in its own magnet assembly which produces a uniform field of about 100 Oe at the film surface. NiFe films deposited directly on Al_2O_3-coated Si substrates show magnetic and transport characteristics consistent with previous ion beam sputtering studies[2] [3]. The easy and

hard axis magnetization loops for a 220Å thick NiFe layer deposited on a 500Å NiO layer are shown in figure 1. The easy axis hysteresis loop is shifted by about 25 Oe. This shift corresponds to a unidirectional surface anisotropy of J_K=0.047 erg/cm^2 which is comparable to the J_K=0.053 erg/cm^2 for NiFe/NiO bilayers deposited using reactive magnetron sputtering[1]. We have achieved exchange fields of over 100 Oe for 50Å NiFe layers and 65 Oe for 50Å Co layers, both grown on 500Å of NiO using IBS.



Symmetric Cu Kα x-ray scans taken on the bilayer films show NiFe (111) and NiO(111), (200) and (220) reflections. Traditional understanding of the exchange anisotropy mechanism indicated that the degree of (111) texture of the NiO film strongly correlates with H_{ex} because the (111) planes of NiO contains uncompensated spins. H_{ex} is plotted as a function of the NiO(111) to NiO(200) intensity ratio I(111)/I(200) in Figure 2. There is a clear trend of increasing exchange bias for films with greater (111) texture. The degree of (111) texture of the NiO films is dependent on the ion beam voltage and current as well and the substrate temperature and bias voltage. The results of this study demonstrate that IBS is a viable method for making NiO exchange-bias films. IBS deposition of NiO may have some advantages over the commonly used reactive sputtering method.

References

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